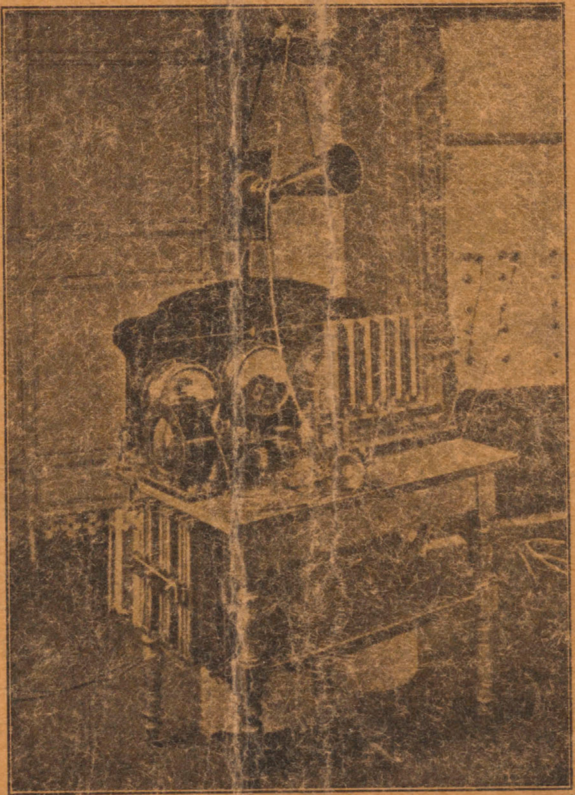
The Wireless Telephone

By H. GERNSBACK



A WIRELESS TELEPHONE STATION

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Paul J. Hackett

P. J. Hackett.

THE WIRELESS TELEPHONE

A Treatise on the Low Power Wireless Telephone, Describing all the Present Systems and Inventions of the New Art. Written for the Student and Experimenter and those engaged in Research Work in Wireless Telephony.

BY

H. GERNSBACK

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Preface

The present little volume is intended for the experimenter doing research work in wireless telephony and the student who wishes to keep abreast with the youngest branch of the wireless art.

The author realizes that the future use of the wireless telephone will be confined to the low power or battery system, as the present instruments, necessitating 220 and 550 volts for their successful operation, are not desirable nor practical enough for every day use.

The wireless telephone of the future must be as flexible as the wire telephone of to-day.

Every farmer will be able to operate his wireless telephone, when the sending and receiving instruments will be housed in a box a foot square, without depending on the lighting current for its operation.

The author predicts that in less than 10 years this stage will have been reached as it is bound to come sooner or later.

Quite a little new matter will be found in these pages and while some old matter has necessarily appeared for the sake of completeness of the book, the author trusts that the necessity of reviewing such matter will be apparent.

The author shall feel happy if this little volume will be the cause to advance the new art if ever so little, and he will be pleased to bear honest criticism and suggestions as to the contents of the book.

H. GERNSBACK.

New York,
February, 1910.

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CHAPTER I.

Damped and Undamped Waves.

If we take an ordinary spark coil and connect a spark gap to its secondary and operate the coil, a steady stream of sparks appear in the spark gap.

To the eye this stream of sparks appears continuous and uninterrupted, in reality, however, small sparks follow each other with great rapidity, too fast to be perceived with the naked eye.

With suitable apparatus, such as Wheatstone's

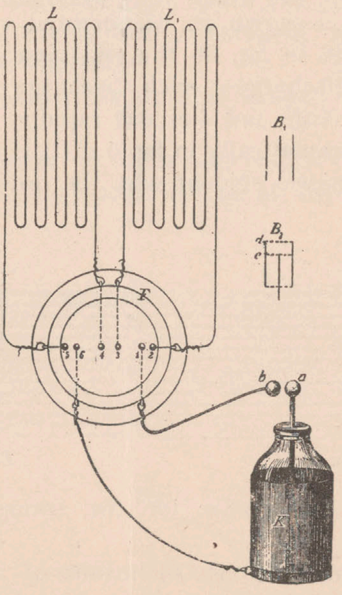

Fig. 1

rotating mirror, fig. 1, we find that each spark is made up of a great many small discharges, each following the other with great rapidity. (fig. 2.)

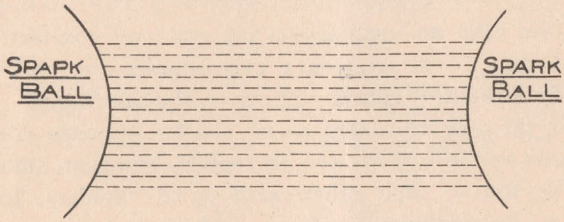

Fig. 2

In fig. 3a, is shown an exaggerated view of the beginning, and in fig. 3b the end view of a spark (oscillatory discharge) ; such discharge is called a damped discharge and dies out rapidly. It is represented diagramatically in fig. 4.

It now becomes evident why the ordinary spark

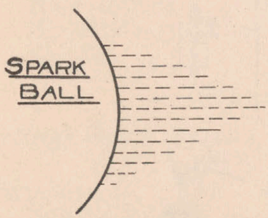

Fig. 3a

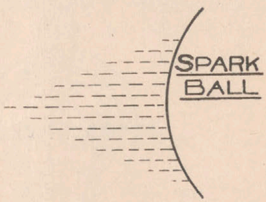

Fig. 3b

discharge is unsuitable for the transmission of speech.

If we would impress by means of any of the following methods, the human speech on above

spark gap, the same would necessarily be "cut up" because the current does not flow steadily and constantly through the spark gap.

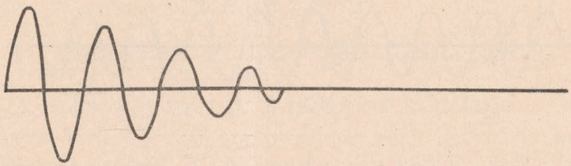

Fig. 4

We must therefore get a spark gap and a current which flows evenly and constantly, without any interruptions whatsoever.

A good comparison on this subject will not be amiss.

Take a pitcher of water and empty it through a coarse sieve—the water will be all broken up and

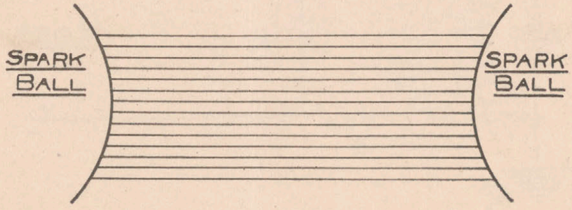

Fig. 5

comes down in small streams. (Damped.) If the same water is poured in a funnel, however, the

water is not broken up any more, but flows "solid." (Undamped.)

Fig. 5 shows an exaggerated view of an undamped

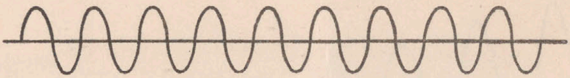

Fig. 6

oscillatory discharge, while fig. 6 shows the diagramatical view of same.

CHAPTER II.

Production of Undamped Oscillations.

The production of undamped oscillations and waves is still in its infancy and very little has been achieved so far.

Most inventors have worked with currents usually of 220 and 500 volts in the primary circuit.

Valdemar Poulsen, the first to produce undamped

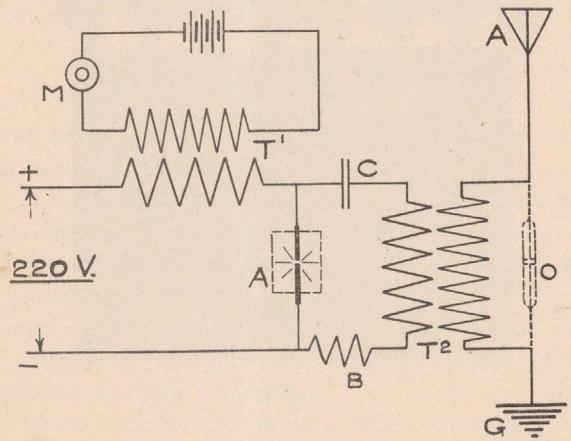

Fig. 7

high frequency oscillations, used the arrangement as shown in fig. 7.

M is the microphone, which, connected to a

battery, is in circuit with the transformer (induction spool) T1.

The direct current of 220 volts flowing through the secondary of T1, operates the arc lamp A the arc of which burns in hydrogen. This, it has been found, produces the high frequency oscillations. The condenser C, the primary of another transformer T2 and a choke coil B are shunted across the arc, while the secondary of T2 is connected to ground G and aerial A.

If we speak now in the transmitter M, an inductive current is set up in T', and as the secondary of same is at the same time the main circuit of the

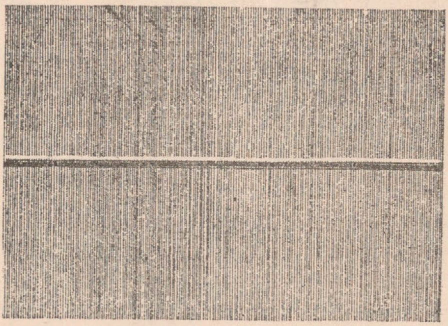

Fig. 8

arc, it follows that the induced current is impressed on the arc which latter will produce the voice.

At the same time the current flows over C, T2, and B and charges the aerial A at one side while flowing down to the ground at G.

The high-frequency oscillations are now radiated by the aerial A, and if words are spoken in M, same

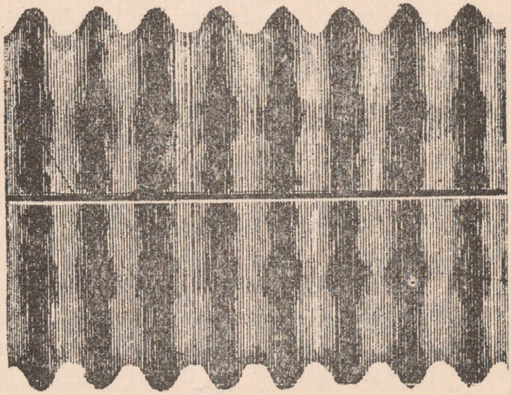

Fig. 9

will be reproduced in the distant receiving station in their true form.

If no words are spoken in M, the high-frequency oscillations will still radiate from the aerial A, but as they have the enormous frequency of 300,000 per second, it is impossible for the human ear to hear same at the receiving side, because the ear is not capable to detect oscillations above 35,000. Consequently nothing is heard.

If we connect the vacuum tube O between A and G a steady glow will fill its gap when the arc is in operation.

This tube connected with an instrument called the oscillograph, which has a small mirror revolving at 140 R. P. M., is used commonly to make the

oscillations of a spark, etc., visible. With the ordinary spark the revolving mirror shows a series of short lines, distinctly visible to the eye.

However, when connected as shown in fig. 7 to a high frequency generator, it is impossible to obtain any figure or picture of the spark.

Instead, a broad white light ribbon is obtained, fig. 8 and the lines are perfectly straight, as if the oscillogram had been taken of a direct current tube.

Fig. 9 shows an oscillogram when words are spoken in M. In this case the vowel O has been sounded.

Thus it is observed that the variations in the transmitter resistance were carried over from the primary source of supply, and caused a variation either in the strength or in the frequency of the oscillating current in the oscillation circuit.

From the foregoing it becomes plain that the future of the low power wireless telephone—as far as can be judged at this stage of the development—is dependent on high frequency undamped oscillations.

A few facts make this plainer. We know that the human speech organ in its natural sound production creates sound waves, the frequency of which lies between 100 and 800. We furthermore know that the overtones which give the voice its characteristic value, sometimes reach a frequency in excess of 5,000.

It therefore becomes evident that in order to reproduce the voice, the electrical discharges must be at the very least 5,000 per second, because only the first oscillation of each wave-train can be utilized.

However, if we would have a frequency of 5,000 per second, the telephone diaphragm would necessarily oscillate at the same frequency and would consequently produce a sound of its own, which necessarily would interfere with the production of the voice, inasmuch as the human ear detects frequencies of this period quite readily.

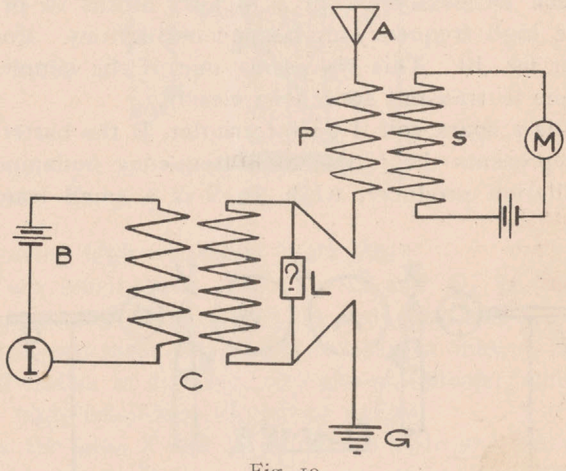

Fig. 10

In fact, it has been shown that only by increasing the frequency above 35,000 the human ear will not detect the sound any more.

We are therefore forced to use frequencies of at least 40,000 per second, if we desire to transmit speech clearly, so that it can be understood distinctly in the distant receiver.

We now understand why the ordinary spark discharge can not be utilized to transmit speech (see fig. 2), because the time elapsed between each discharge is not sufficiently short, and the result is the usual "breaking up" of the voice.

The "missing link," therefore, must be found in the means of creating high frequency oscillations.

We have all the necessary adjunct to transmit speech wirelessly except a reliable means to produce high frequency undamped oscillations. Consider fig. 10. This represents one of the simplest means to transmit speech wirelessly.

C is a spark coil, I an interrupter, B the battery, L represents the future high frequency undamped oscillation producer, while P, S is a small trans-

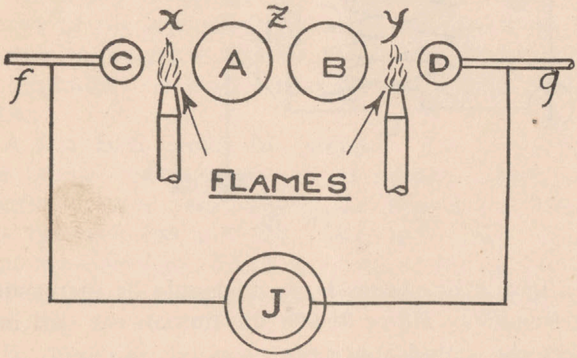

Fig. 11

former used to impress the oscillations produced by speaking into M, on the radiating aerial A.

Koehler High Frequency Gap.

Let us therefore turn to the apparatus, so far devised for the production of undamped high frequency oscillations. Mr. I. Koehler devised the

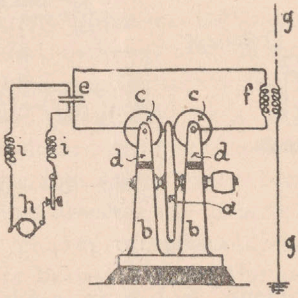

Fig. 12

following high frequency spark gap:

Two small balls, Fig. 11, C and D, ¾ inch diameter are connected to the induction coil J.

Between these small balls two larger ones, A and B, 2 inches in diameter, are placed, between which the high frequency discharge passes.

In the gaps X and Y, two small hydrogen flames, of about ¼ inch flame length, are stationed. These hot flames act as conductors for the current and no sparks will pass at X and Y. A high frequency discharge, however, passes at Z as soon as J is operated.

If the interruptions in the primary are sufficiently fast, a broad flame-like ribbon will be formed as a result of the high frequency oscillations.

Marconi devised the method shown in fig. 12.

Marconi High Frequency Producer.

A strong metal stand having two uprights, b b, carries a metal plate a, which is insulated from b b. Two insulated parts d d, carrying two brass or zinc

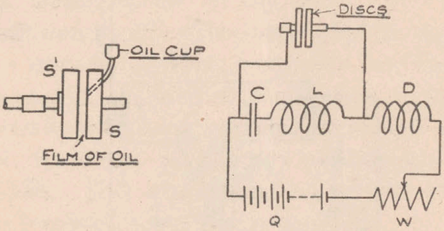

Fig. 13

balls c c, are fastened to b b, from which they also are insulated. The plate a, is revolved at an extremely high speed, and it is claimed that in order to obtain best results, the speed at the circumference must be at least 90 meters per second.

The two balls are so close to the disc, that sparks can jump between them and the disc. A direct current dynamo h, of very high voltage is connected to condenser e, which in turn is in series with the spark balls and the primary of a jigger f, which latter excites the antenna.

As soon as the machine is started and the dynamo is operated, two arcs are formed between balls and disc, which produce the sustained oscillations.

Polyfrequency Arrangement.

A novel device for producing high frequency waves has been patented by a German firm the Polyfrequency company. The two metal discs S

and S1, fig. 13, are mounted so that S is fixed, while S1 revolves with a uniform movement. These discs have been ground together so as to run quite true, and they are nearly touching, being separated only by a thin layer of oil which is fed in from one side. A direct current is passed between the discs, and it is found that the very thin layer of oil gives a resistance which is modified by the voltage, so that it diminshes as the voltage rises. The exact nature of the action which occurs here is somewhat obscure, but in practice it is found that when the oil is constantly supplied between the discs we have a regular and periodic change of resistance and therefore of current. The battery Q and the resistance D are connected to the two discs and in shunt on the discs is mounted the condenser C and the self-induction coil L. In the shunt circuit there are now produced electric waves of high frequency, the frequency being mainly determined by the values of C. and L. When the discs are run at a constant speed with a regular oil feed, the waves are constant in frequency and amplitude.

Heinicke High Frequency Producer.

A German inventor (Heinicke) uses the following device for producing electrical oscillations: Two discs lying parallel are made to rotate in contrary directions by an electric motor. The lower disc H has a set of projecting teeth S, say 200, and on the upper disc G there are disposed two contacts E, F, so that when one contact is on a tooth the opposite one lies in the space between two teeth. Both discs

are rotated at a speed of 2,000 r. p. m. Given twice 200 or 400 contacts made per revolution, since the discs turn at the same time we have 800 such con-

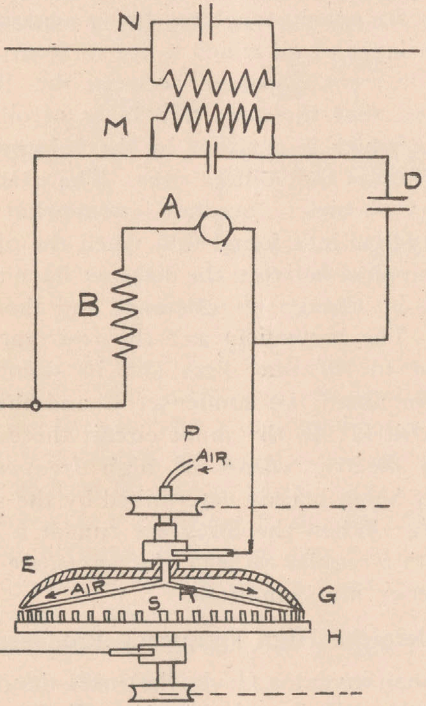

Fig. 14

tacts, and 800×2,000 revolutions gives 1 600,000 contacts per minute. We connect this in a circuit containing the dynamo A and choke coil B. In parallel on the first circuit we use an oscillatory

circuit M connected either direct or using a condenser at D. Electrical oscillations are thus produced in this circuit, due to the sparks of the contact

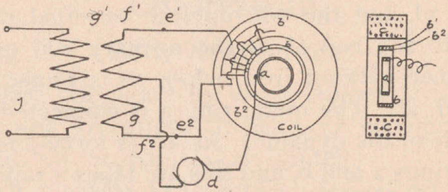

Fig. 15

breaker. Such oscillations are of two kinds in the first, the frequency depends upon the number of contacts per second of the breaker, and in the second it depends on the capacity and self induction of the oscillatory circuit. But in practice we are able to bring forth both these sets of waves into concordance by proper tuning. The oscillatory circuit acts inductively on a second oscillating circuit N, which is entirely closed and is mounted with the aerial and ground. The energy which is radiated by the aerial is thus found to be considerable. For blowing the contacts so as to prevent an arc from forming there is used an air current supplied at P. R. S.

Another method is as follows:

Two concentric metal rings are placed inside a circular magnetizing coil C and in the position shown with reference to the magnetic field. Ring a is connected directly to one pole of a dynamo, and

it is made in one piece. It can be water-cooled if need be. Ring b is formed like a commutator with various segments as seen in the plan view We connect all the even numbered segments to the same terminal e1 and the odd ones to terminal e2, then join e1 to the end f1 of the primary coil gg' of a transformer without iron, while e2 is joined to the other end, f2. The metal ring a is connected to the other pole of the dynamo. An arc is formed between the two rings a and b, and this arc takes a rapid rotation by the action of the field. The effect is extremely rapid and comes to some thousands of turns per second if the arc is a strong one. The arc thus passes from b1 to b2 in a very short time, and on account of the connection of these segments with the transformer we have an alternating current in f1 and f2 and a succession of current inversions which is extremely rapid, so that we take off a high frequency current from the secondary j.

Undoubtly the future will bring many more devices of this kind, especially simpler ones, using low power and giving a high efficiency.

CHAPTER III.

Early Experiments.

Wireless telephony by electromagnetic induction is not a new invention. It has been known for over 50 years, but its use is very limited.

One of the best and simplest devices which may be used to transmit speech over small distances up to 50 feet (through stone or wood walls) can be made as follows:

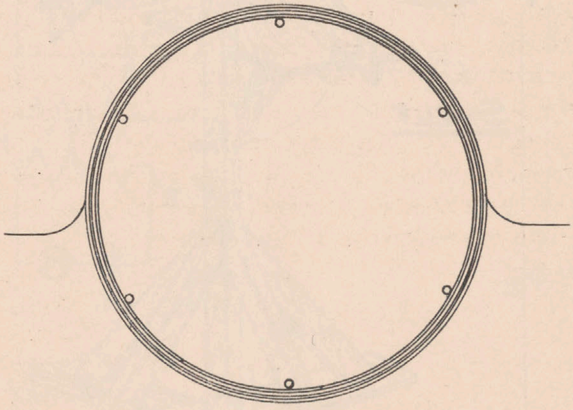

Fig. 16

How to Make a Simple Wireless Telephone.

On the wall or on a large table tack 6 12 nails in form of a circle of 5 feet diameter, fig. 16.

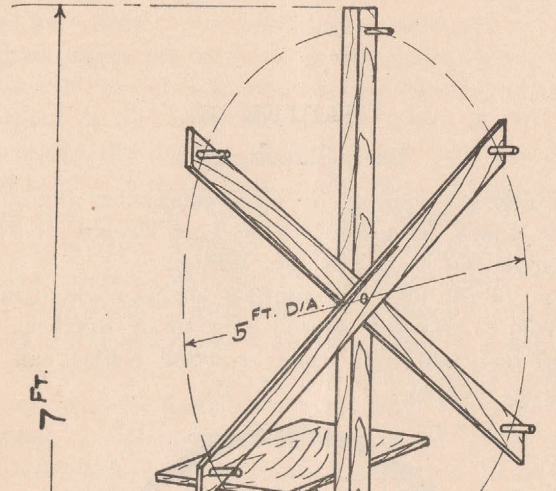

Fig. 17

Around the nails wind 80 turns of No. 28 B. & S. wire, enameled wire preferable. Bring out two leads as shown. When completed, wind tape around the coil so the turns will not unwind. Two layers of tape are advisable as the finished coil will be somewhat stiffer then.

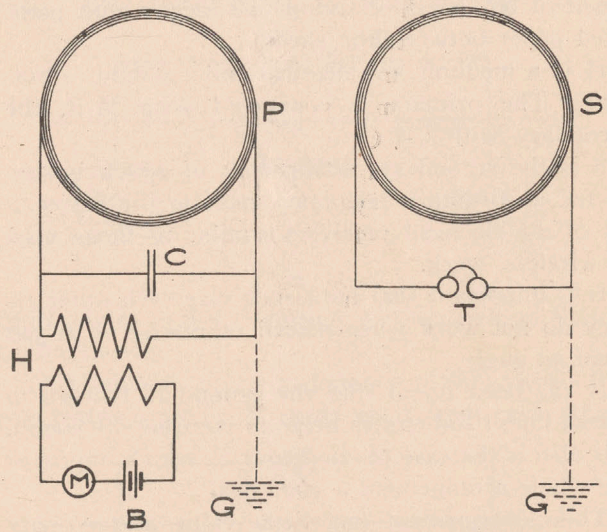

Fig. 18

This coil is the secondary.

On the same nails wind 40 turns of No. 18 B. & S. wire and finish it with tape the same as secondary.

This coil is the primary.

Two portable wood stands should then be built of wood laths as per dimensions shown in fig. 17.

A shelf is also provided on which to place the instruments.

Each wire coil is attached to stand as shown in dotted lines.

Fig. 18 shows the connections.

P is the primary coil, M a common microphone transmitter, B 6-10 dry cells, C a condenser composed of 50 sheets of tinfoil 5x3 inches with parafined paper between the sheets.

H is a medium size medical coil (without vibrator). The primary is connected with M-B, the secondary with C-P.

S is the secondary, to the ends of which is connected an ordinary telephone receiver, or better, a set of double head receivers similar to those used in wireless work.

It is important that both coils face each other, as they do not work when placed otherwise or at too great an angle.

It has been found that the ground G (shown in dotted lines) sometimes helps to increase the sound, this also is the case of condenser C, which improves the whole arrangement a good deal.

This arrangement has little value and is only used for demonstration purposes, and works up to 50 feet.

The use of an aerial does not seem to improve it.

The outfit may be regulated by cutting in more or less battery a B till best results are obtained at the receiving end.

Closed Circuit Wireless Telephone.

We must also mention another method of wireless

telephony, namely, the closed circuit wireless telephone.

Like the induction telephone, the closed circuit systems are of little value, the greatest distance so far covered being 3½ miles.

Fig. 19 shows the sender. Two copper plates 2 feet square are sunk in the ground about 4 feet deep. The plates must be sunk in edgewise at

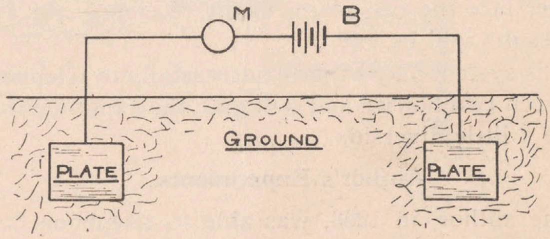

Fig. 19

right angles with the surface of the earth as shown in illustration.

To telephone up to a distance of 500 yards, the two plates must be 25 yards apart from each other,

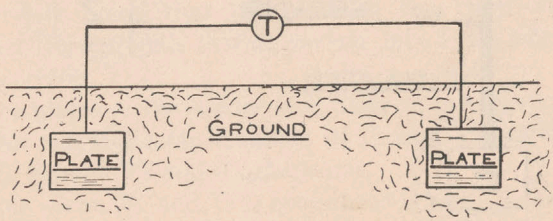

Fig. 20

for shorter or greater distances, the plates must be separated proportionately to above figures.

M is the microphone, B the battery.

The receiver is shown in fig. 20. T is a telephone receiver of 50 or 75 Ohms. The lower the resistance, the betters the results. Two copper plates are provided again, of the same size as those of the sender and spaced the same distance apart as those of the sending station.

It is very important that the two plates of the sender face the two plates of the receiving end, else no results will be had.

This system may be used successfully to telephone between two houses and will give the experimenters quite a little diversion.

Author's Experiments.

The author, in 1903, was able to telephone over

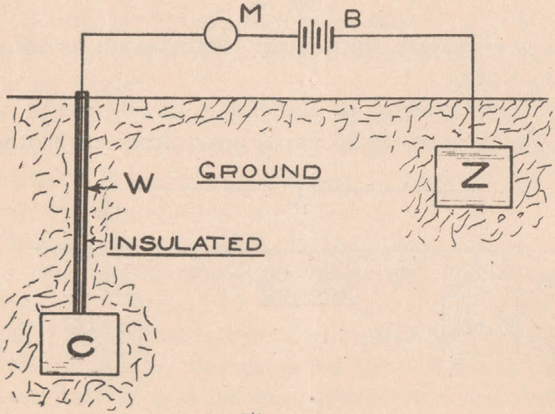

Fig. 21

a distance of 3 miles by using the arrangement as shown in figs. 21 and 22.

Two plates, fig. 21, 3 feet square, one of copper and the other of zinc, were sunk in the ground in such a manner that C was buried 15 feet deep and

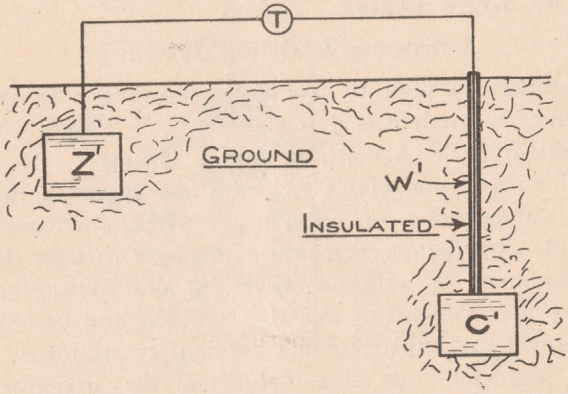

Fig. 22

Z only 2 feet below the surface. Microphone M and battery B were provided as shown. At the receiving side, two similar plates of similar size C1 and Z1, were sunk in the same fashion, the only difference being that the plate at the right was buried 15 feet, while that at the left only 3 feet below the surface.

The plates of the sender face those of the receiver.

The perpendicular distance of C and Z was 300 yards, that of Z1 and C1 the same.

The wires, W and W1, leading to C and C1 were carefully insulated and around all plates a saturated solution of chloride of zinc was poured. This had a double effect. Firstly, it set up an electromotive force between all the plates, and, secondly, chloride

of zinc being very hygroscopic, it kept the earth moist and conductive around the plates.

This system proved very successful and was in use for over 8 months.

Armstrong & Orling System.

Another method to telephone wirelessly by the conductive method is described in U. S. Patent No. 744,001 by J. T. Armstrong and A. Orling.

This invention relates to means and apparatus for the transmission of speech and other articulate sounds to a distant receiver or receivers without the employment of wire or other like connection between the transmitter and the receiver, and has for its object the improvements hereinafter set forth.

In carrying out this invention the inventors

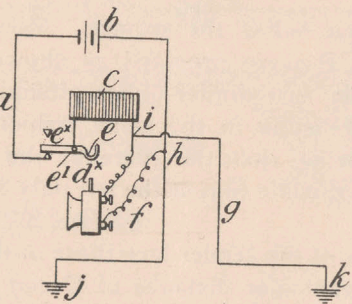

Fig. 22a

provide the transmitting apparatus with two or more earth connections, through which are conducted a combination of high-potential discharges and low tension currents whose circuit or

circuits are completed through numerous lines of current-flow which traverse the earth. The trans-

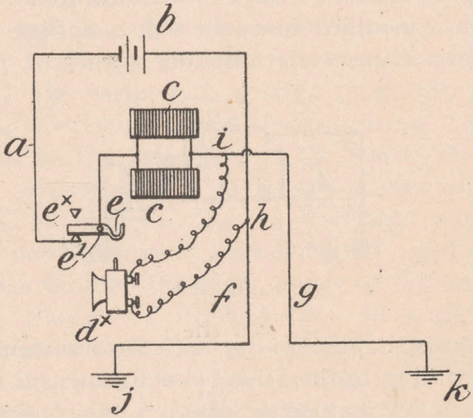

Fig. 22b

mitted impulses enter the earth by one of the said earth connections and after traversing the same return to complete the circuit through the other. The

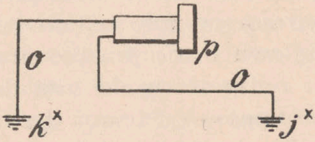

Fig. 22c

receiving apparatus (hereinafter described) is also provided with two or more earth connections which are adapted to cut the said lines of current-flow (in the neighborhood of the distant receiver) at points of different potential, causing some of the trans-

mitted energy to pass through them and to actuate the receiver.

Fig. 22a shows one form of transmitter. Fig. 22b shows a modified form thereof, and Figs. 22c and 22d are respectively different forms of receiving

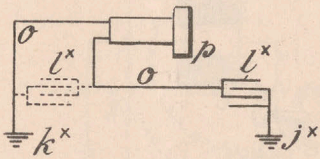

Fig. 22d

apparatus adapted for use with the transmitter.

According to the arrangement shown in Fig. 22a, they employ an electric circuit a, which is provided with a battery b, or other convenient source of energy, a self-inductance coil c, a microphonic or any other suitable telephone-transmitter dx, and a switch ex, which is pivoted at e1 and provided with a hook e2, upon which the transmitter dx is adapted to hang when not in use, so that its weight may cause the said switch to open the circuit. Suitable connections f and g are made with the circuit a at h and at i on opposite sides of the transmitter dx and are respectively led to earth at j and k in such a manner that the earth is in shunt-circuit.

According to the construction shown in Fig. 22b, a plurality of self-inductance coils c is employed.

In operation the varying resistance of the transmitter dx causes a fluctuating current to pass through the coil or coils c, with the result that

"extra" currents are induced, the circuit of which is completed through the transmitter dx and the earth, which is in shunt thereto. At each increase in the resistance of the transmitter dx a larger proportion of the low-tension-battery current will pass through the earth with a large proportion of the induced direct high-potential extra current. At each decrease in the resistance of the transmitter dx a larger proportion of the battery-current will pass through the coil or coils c and a large proportion of the induced inverse high-potential extra current will pass through the earth, owing to the resistance of the transmitter dx and the opposing electromotive force of the battery-current. The electrical effects that are thus led to earth at j and k (which connections are preferably as far apart as practicable when communication is carried on over great distances) set up lines of current-flow which extend to very considerable distances and are intercepted in the neighborhood of the receiver (see Figs. 22c and 22d) by its earth connections jx and kx. These connections, with the receiving part o of the circuit constitute a species of shunt through which some of the transmitted energy flows.

The receiving apparatus consists of a telephone p, by means of which the passage of the transmitted energy through the receiving shunt o may be detected.

In some cases they employ a condenser lx, as shown either in full or dotted lines in Fig. 22d, to obviate the effect of earth-currents.

CHAPTER IV.

The Spark Wireless Telephone.

The simplest spark telephone is shown in figs. 23 and 24.

The microphone M is in series with a 10-12 volt battery and the primary of the spark coil C. The spark gap S is bridged across the secondary; it is connected with aerial A and ground G.

In his experiments the author found that best results are obtained when the spark gap is made of two finely pointed carbons, about 1-64 of an inch

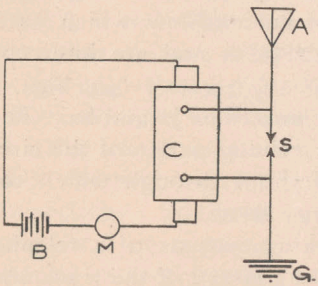

Fig. 23

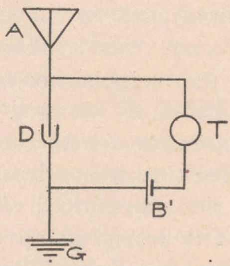

Fig. 24

apart from each other. A 2 inch spark coil was used and a sensitive microphone M, which could carry 1 ampere without undue heating.

The receiving side, fig. 24, has an electrolytic

detector D, telephone receiver T, battery B1, aerial A and ground G.

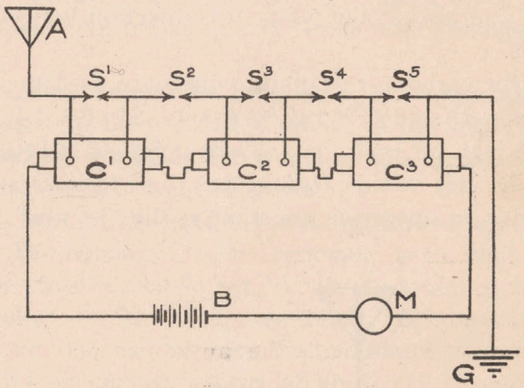

Fig. 25

This system works fairly well over small distances but the voice can not be heard at all times, for the reasons explained in chapter 1. Entire words and consonants drop out, as the rate of sparking in the gap is far too slow.

Words containing many vowels are made out best such as: Halloh; you; papa, etc. The vowel "e" is never heard well.

On the other side whistling is clearly heard and "breaks" occur rarely.

Author's Arrangement.

Another early arrangement of the author's is shown in fig. 25.

Three 1 inch spark coils, C1, C2, C3, have their primaries connected in series with a battery and microphone.

A Quintuple spark gap, S1, S2, S3, S4, S5, is formed as shown, between the secondaries of each coil and also at the point of connection between the coils.

Fine carbon or graphite points are used for spark gaps. Distance between points S1, S3, S5, were 1-64 inch for each gap. That of S2, S4, a little less.

The idea of this arrangement was to have at least 2 gaps in operation constantly, the "breaks" there-

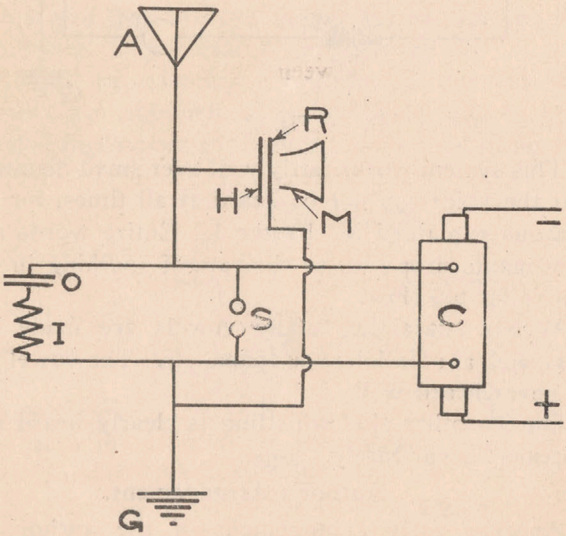

Fig. 26

fore were less frequent and words could be heard quite well at times in the receiver.

Fessenden's Condenser Transmitter.

This is illustrated in fig. 26. C is the coil, S the spark Gap, I an inductance in series with condenser O.

Fessenden thought by influencing the inductance or capacity of the oscillation circuit in the aerial by constructing a transmitter which would accomplish this, the problem could be solved.

He consequently used a novel transmitter shown in fig. 26, where H is a stationary plate and R another plate which is set to vibrate when words are spoken in M. This causes R to constantly change the distance between the two plates, and consequently the capacity of the condenser H, R, varies in unison with the vibrations of the voice.

McCarthy Wireless Telephones.

This youthful Californian genius who died at a very tender age, did quite a little work in wireless telephony. Although none of his systems came into actual use a few of them are mentioned here.

One of McCarthy's first systems (U. S. Patent No. 857,530) is as follows:

A, fig. 27, is a mouth-piece.

2 is a tube into the side of which the mouthpiece opens. At one end of this tube is the microphone transmitter as at 3, and at the opposite end of the tube is the transmitter diaphragm 4.

5 represents an induction or Ruhmkorff coil having two primary windings of wires 6 and 7, and in connection with these a secondary insulated winding as at 8. The first primary wire 6 is connected

through a wire 6a and a binding post 9, with the contact screw or point 10, which is adjustable in the non-conducting case within which the diaphragm 4 is fixed, and this diaphragm has the contact 11 corresponding with the contact 10. The contacts may be of platinum. Upon the opposite side of the

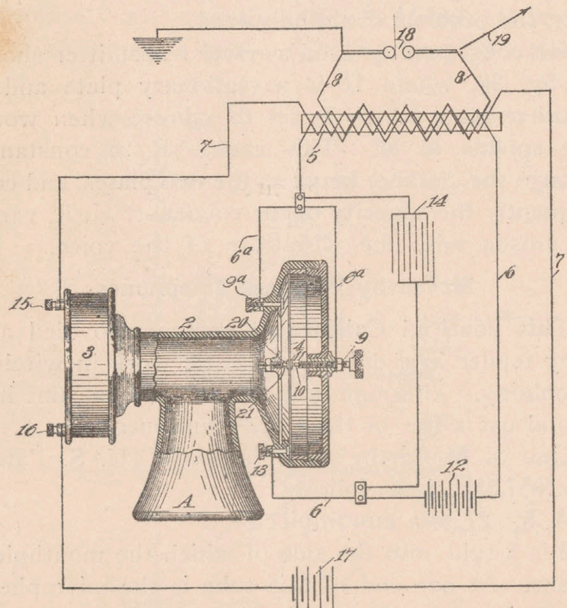

Fig. 27

diaphragm 4 is another contact 20, and 21 is a contact supported in opposition to the contact 20.

6a is a wire or metallic connection between contact 21 and contact 10.

The points 20 and 21 are normally in contact and through the connections with the battery form a closed circuit, while the circuit through the contacts 10 and 11 is normally open. When a vibration of the diaphragm 4 takes place the circuit through contacts 21 and 20 is broken by the outward movement of the diaphragm, and a circuit is established through the contacts 10 and 11.

In the operation of the device, words spoken into the mouth-piece will cause the vibration of both the diaphragms 3 and 4. The effect of these sonorous vibrations on the diaphragm 4 is to cause it to make and break the circuit in unison with the vocal sounds; first between contacts 10 and 11, and then between 20 and 21. The effect of the sonorous vibrations on the microphone 3 is to vary the current in the second primary in unison with the sonorous vibrations. The resultant effect on the secondary causes a spark to be generated at the spark gap 18. The spark produced bears all the characteristics of the vocal or other sounds, thereby imparting waves to the etherial medium which will be recorded on a receiver at a distance.

From the binding post 9, the wire 6a connects with wire 6 of the coil, thence the wire 6 connects with the battery as at 12, thence to the binding post 13 of the transmitter 4.

14 is a condenser having wires connecting the binding-posts 9a and 13 with the primary wire 6, and this serves to prevent sparking at the contacts of the transmitter.

The microphone transmitter 3 has the binding-posts 15 and 16 with which the ends of the second primary wire 7 are connected, with a battery interposed as at 17.

In the operation of the device, words spoken into the mouth-piece A will cause a vibration of both the diaphragm 4 and that within the transmitter 3, and the vibration of the microphone transmitter being synchronous with the vibrations of the diaphragm 4, the effect produced by the double primary winding of the coil 5 is transmitted through the secondary winding 8, and the discharge points 18, to the aerial conductor in the line shown by the arrow 19, and thence to any suitable receiver.

It has been found that any primary of a Ruhmkorff coil which has a second layer of wire wound over it serves to choke off the effect of current in the first primary on the secondary, if it be suddenly short-circuited, and that by connecting an ordinary microphone transmitter across the ends of this second primary, it will vary the effects of the first primary on the secondary when the mouthpiece is spoken into without the aid of a battery when used over short distances, but to obtain the same effect over long distances a few battery elements are used.

Another McCarthy patent, a curious combination of an arc and a spark coil (U. S. Patent 867,895) is described herewith. (Fig. 28.)

In this invention an induction coil is employed having a secondary winding A, and two primary windings 2 and 3. The secondary coil is connected

in the usual manner to the two sides of a spark gap 4.

5 is a suitable source of electrical energy, and one of the primary coils 2 is put in series with this source of electrical energy, and the current while flowing through this primary is continually varied by an interrupter as indicated at 6. The other primary 3 is connected in series with the same source of electrical energy in such a manner that the current through this primary coil is made to flow in the opposite direction to the previously described current in the primary 2.

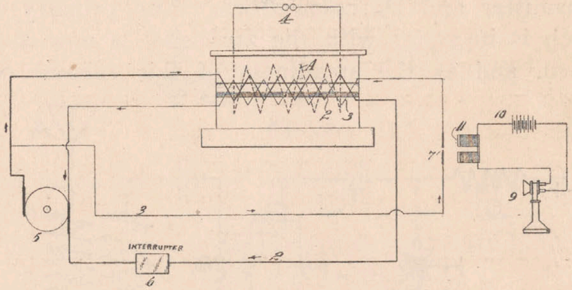

Fig. 28

An arc light 7 is introduced in series in the primary 3, and the current flowing through this primary in series with the arc light being a continuous one, generates an unvaried magnetic field which, owing to its steadiness, neutralizes the variations of the magnetic field of the primary 2 which are caused by the interrupter 6, and consequently no discharge takes place at the spark gap 4.

In order to cause discharges which will approximate the variations in the human voice, the variations of the current in the circuit 3, which is in series with the arc light, is effected by means of a telephone transmitter 9 which is connected through batteries 10 to an electro magnet 11. This magnet is energized by the impulses created by the voice acting through the diaphragm of the transmitter, and the magnet is placed in close proximity to the arc light. The lines of force thus generated through the magnet influence the arc so that the current flowing through the circuit 3 and the arc, are varied in unison with the variations induced through the transmitter and its connections. The primary 3, which is in series with the arc light, is now also varied, and as the steadiness of this current on

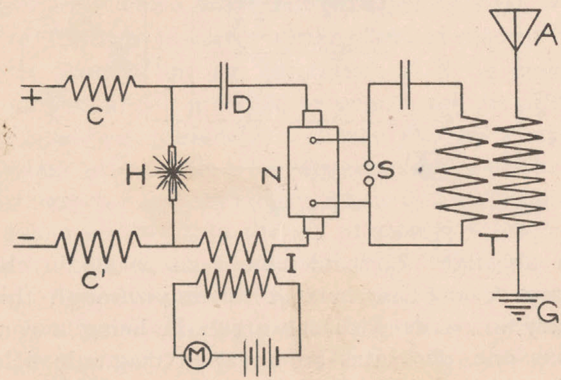

Fig. 29

which the neutralization of the magnetic field of the other primary depended, is now varied, similar

vibrations will immediately occur in the magnetic field of the primary 2, and the discharges through

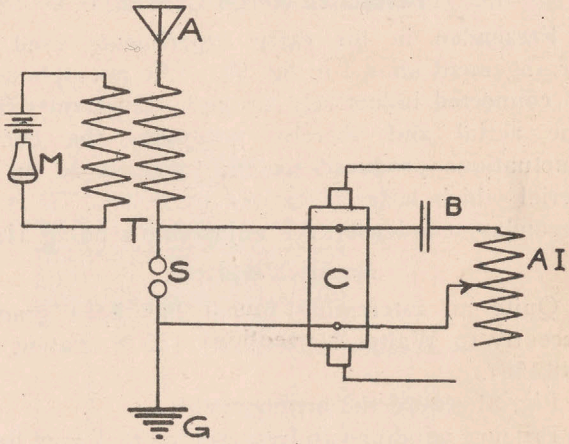

Fig. 30

the spark gap will be varied by the impulses of the human voice energizing the electro magnet, and through its producing variations in the arc light and in the circuit in which it is located.

Nussbaumer Arrangement.

In the foregoing system an interrupter and arc were used simultaneously, in the Nussbaumer arrangement the arc is used as interrupter, fig. 29.

H is the arc, D the condenser to prevent the current to short through the primary coil N. The microphonic control is not direct but coupled to the primary circuit by means of transformer I. M is the microphone. The secondary circuit is coupled

loosely through transformer T, to aerial A and ground G.

Fessenden Aerial Control.

Fessenden in his early experiments used the arrangement shown in fig. 30. The microphone M is connected inductively through transformer T to the aerial and thereby impresses the current fluctuations produced by the voice in M on the aerial which latter is excited by coil C. B is the secondary condenser, AI, adjustable sending Helix.

Bathrick System.

Quite an interesting patent has been granted recently to Walter N. Bathrick (U. S. Patent No. 948,156).

Fig. 31 shows the arrangement.

Primary windings are represented by heavy lines; secondary windings and connections by light lines. The light lines merging into the heavy lines indicate the connection in series between the secondary and primary windings in each separate circuit. Right and left sloping lines (either light or heavy) denote windings with normal differences in field polarity.

In fig. 31 the electro-magnetic waves are produced primarily from a large induction coil or inductorium consisting of one or more cores of soft iron wire C' C'', and C''', and a primary coil P' in the circuit of a source of electrical energy B' with a current of frequent interruptions from an interrupter I, and a secondary S, with its spark gap s g, and aerial and ground connections. Two other primary coils P'' and P''' are placed in position to influence the same

field. All three primaries, P', P'', and P''', may be wound upon the same soft iron wire core, but to lessen the inductive effect of one primary coil upon

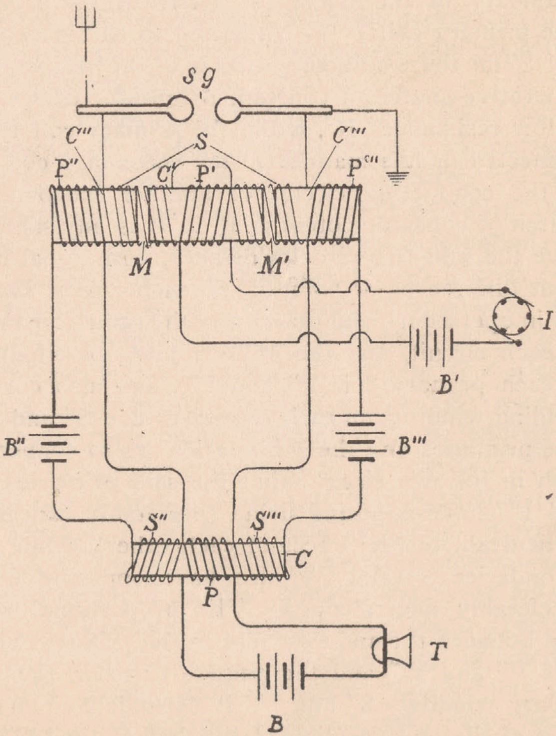

Fig. 31

another, the secondary coils S are wound between each of the primary coils P', P'', and P''' with gaps

at M and M' of air or non-conducting material. The secondary coils S are influenced by the mutual induction and resultant fields of all the primaries P', P'', and P''', thereby controlling and governing said secondary in the circuit of electrical oscillations. The primary coil P'' is connected to the secondary coil S'' in the conducting circuit of an independent generative source of constant potential, (preferably of low resistance) B'', while the primary coil P'' is connected in like manner to the secondary coil S''' in the conducting circuit of another independent source of constant potential B'''. It is advisable to have the said two circuits balance, with equal constant differences of potential in each circuit (when not in operation), and practically the same resistance in each circuit, and the same number of windings in each primary coil P'' and P''', and also corresponding windings in each secondary coil S'' and S'''. The primaries and the secondaries are so connected each in its own circuit, that the said primaries P'' and P''' have opposing fields (preferably canceling or neutralizing the effect of each other), while the secondaries S'' and S''' also have opposing fields (preferably neutralizing). The proportional relation between the ampere turns in the primary windings P'' and P''' and the ampere turns in the secondary windings S'' and S''' is dependent upon the ratio of the cross section of the field C'' and C''' to the cross section of the smaller field core C, and upon the amount of constant E. M. F. and the resistance in each independent circuit. The said secondaries S'' and S''' are wound upon the ends of a core C of

the soft iron wire, and the transmitter primary P is wound on the middle portion of the same core. While it is desirable to have many turns of winding in the secondaries S" and S"', the resistance of each secondary coil must be kept low in comparison with the rest of the circuit, with the necessary cross-section to each secondary's magnet wire to safely carry the current in the circuit.

In the mode of operation of this system, waves of sound or speech impinge upon a diaphragm, varying the resistance in a transmitter T, and synchronously varying the current strength in a primary P, producing concomitant fluctuations in the magnetic field of the core C and inducing an electro-motive force in both secondary coils S" and S"'. As herein described, the secondaries (each in an independent circuit with its source of electrical energy of constant potential) are so connected to oppose in their fields, consequently the induced E. M. F. will act in opposition to the constant E. M. F. in one circuit, and will act in conjunction with the constant E. M. F. in the other cicuit. Variable opposing potentials produce variable decreases in current strength in one primary, while the coincidence of variable induced potential with constant potential, produces variable increases in current strength in the other primary. Opposition and coincidence of induced potentials synchronously in each circuit, S" B" P" and S"' B"' P"', are variable, alternating, and in accordance with the fluctuations of current in the sound-controlled transmitter primary P. The fluctuations of current strength in

both primaries P'' and P''' cause fluctuations in the fields C'' and C''', which in turn modify and intensify

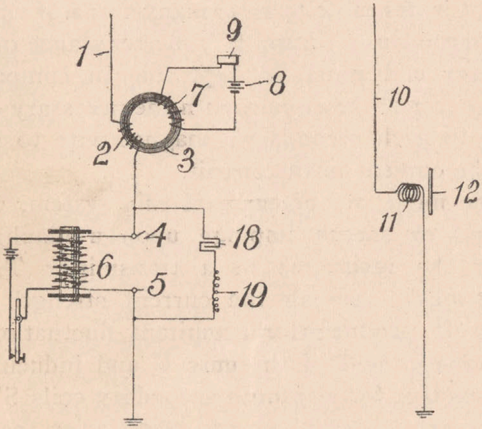

Fig. 31a

the field C' of the interrupted primary P'. The resultant fields generate electrical oscillations in the secondary S, corresponding to the waves of sound or speech.

Fessenden System.

In U. S. Patent No. 706,747, Fessenden describes a system of wireless telephony which should have large interest for the student.

In general terms the invention consists in mechanism or apparatus at the sending-station for the generation of electromagnetic waves or impulses and the modification of the character of the waves by sound-waves or other desired means and of suitable mechanism or apparatus at the receiving-station

operative by the waves or impulses from the sending-station to give a signal or indication.

By the term "electromagnetic waves" as used herein is meant waves of a wave length, long in comparison with the wave length of what are commonly called "heat waves" or "radiant heat." By "grounded conductor" is meant grounded either directly or through a capacity, an inductance, or a resistance, so that the current in the conductor flows from the conductor to ground, and vice versa, when the electromagnetic waves are generated.

Figure 31a is a diagrammatic view illustrating forms of apparatus for the sending and receiving stations. Fig. 31b is a similar view illustrating a modification of the sending apparatus.

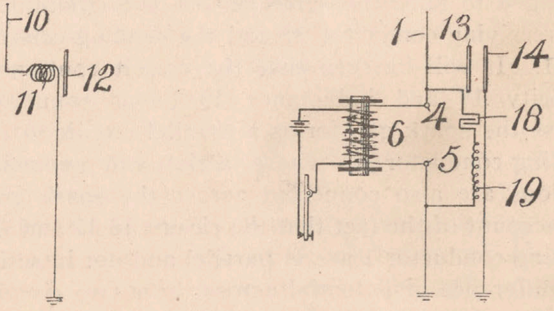

Fig. 31b

In the practice Fessenden provides at the sending-station a conductor 1, of suitable construction and arrangement, and connects the same to one terminal of a coil 2, surrounding a core 3, preferably annular

in shape and preferably formed of fine iron wire. The other terminal of the coil is connected to one of the knobs or terminals 4 of an induction-coil or other suitable generator 6, capable of producing practically continuous and rapid oscillations in the conductor. The other terminal 5 of the generator is connected to ground. A second coil 7, forming a part of the circuit for the battery 8, is placed on the core 3, and a transmitter 9, preferably microphonic in construction, or other mechanism capable of modifying the current in the circuit is included in the circuit of the battery and coil 7. A capacity 18 and inductance 19 are connected in shunt to the spark gap for the purpose of maintaining sustained oscillations of practically constant frequency.

The capacity 18 and inductance 19 should be arranged to have the same period of oscillation as the receiving-conductor 10 and the sending-conductor 1. It will be seen that the circuit containing capacity 18 and inductance 19 being connected across the spark gap forms a parallel circuit in the sending-conductor 1, whose aerial and grounded sections are also connected across the spark gap. On account of the fact that the circuit 18 19 and the sending-conductor 1 are in parellel and not in series the difference of potential across these two circuits is the same, while the currents in the two circuits are different, this construction being thus differentiated from a series connection in which the circuit 18 19 would be connected electrically between the aerial portion of the sending-conductor 1 and the ground.

At the receiving-station is a conductor 10, connected to one terminal of a mechanism capable of responding to oscillations in the conductor 10. A form of mechanism adapted to the purpose consists of a coil 11, having one terminal connected to the conductor and the other terminal grounded. A telephone-diaphragm 12, formed of metal or consising of insulating material having a metal plate or coil of wire secured thereto or any other suitable construction adapted to vibrate in unison with changes of current produced by the waves radiated from the sending-station, is suitably supported in operative relation to the coil 11. The apparatus at the receiving-station is tuned or made resonant by any suitable means known in the art to the sending conductor 1. The terms "tuned" and "resonant" are used herein one to include the other. When an alternating current is set up in the conductor 10, as by waves or impulses from the sending-station, such current acts to repel or attract the diaphragm, according to the time constant of the metal part of the diaphragm, through induced currents set up in the diaphragm.

When the generator is operated, the diaphragm 12 will take up a mean position relative to coil 11, the distance of such position from the coil varying with the intensity of the oscillations in the sending-conductor; but when the current in the circuit of the coil 7 is modified or changed, as by speaking into the transmitter, the permeability of the core 3 is correspondingly changed or modified, thereby producing a corresponding change or modification

in the self-inductance and a change in the frequency or the natural period of vibration of the sending-conductor 1, which is thereby thrown out of resonance with a resonating circuit 18 19, connected in parallel to said sending-conductor 1, and due to this failure in resonance, producing a corresponding change or modification in the intensity of the waves or impulses given off by the conductor 1 and in the intensity of the oscillations produced in the receiving-conductor. The changes in the intensity of the oscillations will produce corresponding changes in the mean position of the diaphragm 12, such changes corresponding to the vibrations of the diaphragm of the transmitter, exactly reproducing any of the waves or impulses which effected the transmitter. The same result may be effected by changing the capacity of the conductor 1, as shown in Fig. 31b. To this end the conductor 1 is connected to a fixed plate 13 of a condenser, while the other plate 14 is formed by or connected to a diaphragm capable of responding to waves or impulses. As the plate 14 in vibrating moves toward or from the other plate the capacity of the conductor 1 is changed, correspondingly altering the intensity of the waves or impulses generated by the conductor.

CHAPTER V.

Multiple Spark Systems.

As stated in the previous Chapter, it is almost impossible at the present stage to transmit the human voice wirelessly by means of the ordinary spark coil, because of the relatively long pauses between the discharges.

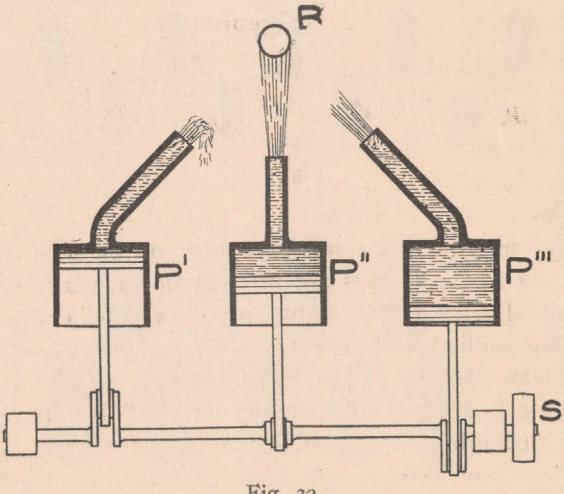

Fig. 32

Many inventors therefore thought of connecting a plurality of coils in such a way that always one coil at least would be discharging.

In other words, they used a multiphase current for obtaining a continuous succession of spark discharges.

Fig. 32 represents a hydraulic analogy of the principle.

Three Pumps P', P'', P''', are arranged in such a manner that their muzzles point on a certain object, B.

The pistons are all connected to a common crank shaft, S.

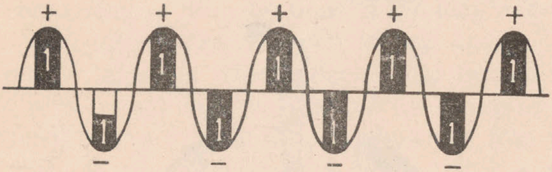

Fig. 33

By studying the arrangement it will be seen that as long as the pumps are in operation and are well supplied with water, the point B will be continuously supplied with water.

In the position shown in fig. 32, the piston of P' just starts on the return stroke, while P'' is only half way through discharging, while P''', just starts.

The same phenomenae must of course hold good for electrical waves. This can be easily seen in fig. 33, which represents the waves emitted from a single spark coil. Let the black spaces represent the waves. As will be seen the impulses are far apart from each

other. Compare this with a single pump working in fig. 32.

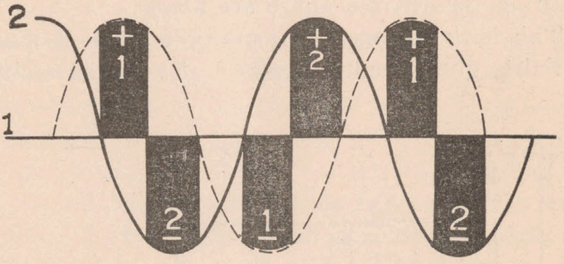

Fig. 34

In fig. 34 the waves of two coils are represented. As will be seen, there is still a period when no waves are emitted (the blank spaces). This is to be compared with pump P' and P" working only, fig. 32.

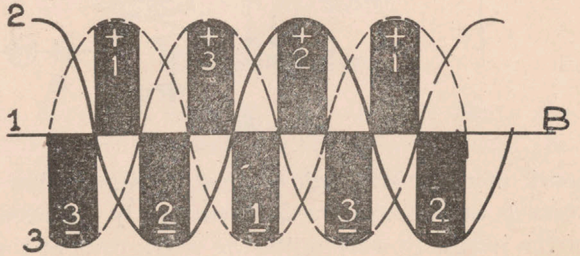

Fig. 35

In fig. 35, the waves of 3 coils are represented (Three pumps in fig. 32).

A continuous wave is obtained by this method as no portion of the line B (representing the antenna) is at any time free of impulses. Compare with fig. 34 where a and b are blank.

This is the theory of the multiple spark method.

Fairly good results may be had with the multiple

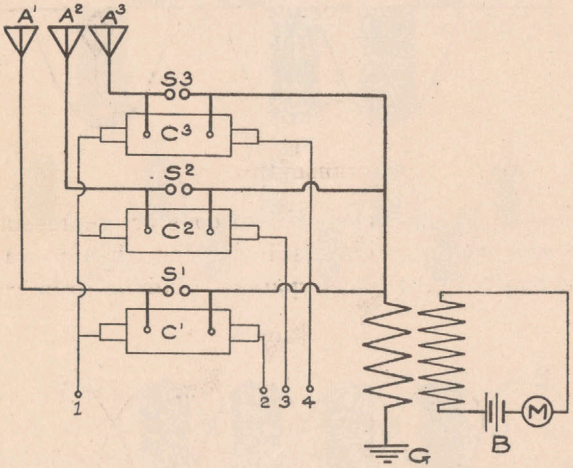

Fig. 36

spark method, although it must be stated that the voice is not always transmitted clearly, on account of the irregular working of the spark coils at times. To cover smaller distances up to 3 miles, however, the multiple spark system presents many advantages.

Fig. 36 represents such a system. Three spark coils C1, C2, C3, (1 to 2 inch spark) are arranged as

shown. One side of each spark gap S1, S2, S3, is grounded to a common ground, while the other side of each of the three spark gaps is connected to a separate and independent aerial A1, A2, A3. These aerials are not in metallic connection, but are all of the same capacity. This is quite important.

The primaries of the coils on one side are connected together and go to post 1. The other ends each go to one post 2, 3, 4. Each of these are in star connection of a three phase alternating current machine. 1 goes to the common field connection of the machine.

The microphone transmitter may either be connected inductively in circuit 1, or in the ground at M through battery B, or else at a point in the star connection.

It is not necessary to go into details of these star (or mesh) connections, as the student will find them in any alternating current handbook.

Mesh Connection.

Fig. 37 shows another form of three phase discharger, mesh connection. The primaries and secondaries of coils are in series, while three Tesla transformers T1, T2, T3 are connected at points A, B, C, of the secondary circuit of the coils. The secondary circuits of the Tesla transformers are also in series but the ends are connected to ground and aerial as shown.

The three wires of the alternating current, three phase system are connected to points 1, 2, 3, of the

primaries. The transmitter is connected as shown in fig. 36.

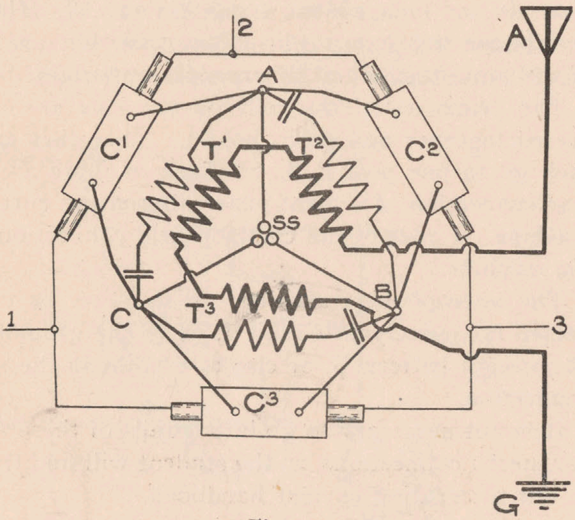

Fig. 37

This system will only work when all the spark gaps are so adjusted that the discharges correspond exactly to the phases of the main current.

It will be easily understood that waves of the same length and period are radiated from the aerial no matter which spark gap is acting at the time.

Therefore the aerial is excited continuously, the same as the point B in the analogy fig. 32 is continuously supplied with water.

CHAPTER VI.

Transmitters.

The main difficulty in the development of wireless telephony has always been centered in the transmitter.

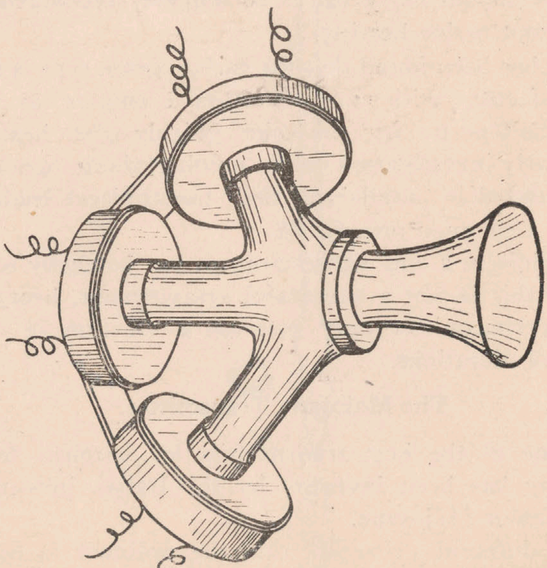

Fig. 38

It takes but a second's reflection to understand that transmitters as used in wireless telephony must

carry a very heavy current, to handle the large amount of energy used in the new art in transmitting.

The ordinary carbon-grain or carbon-granule transmitter as found on regular telephones, or as manufactured by telephone manufacturers, is entirely inadequate as even the best of these cannot be loaded with more than ¼ ampere continuously, whereas microphones used in wireless telephone work should carry up to 20 amperes continuously without undue heating.

It has been found that the carbon-grain type is not satisfactory with currents above 1 ampere, as the grains tend to "fry" or "cake" quickly when heated.

Early investigators used a number of microphones connected in parallel, all their mouthpieces leading into a common one, fig. 38.

While in a way satisfactory, it can be easily seen that this is not a successful arrangement, because each transmitter only received a fraction of the sound vibrations.

The Majorana Transmitter.

One of the best transmitters for wireless telephony has been invented by the Italian inventor, Professor Majorana.

A different principle from the ordinary is used here, and as the instrument uses the action of a liquid, it is known as the "hydraulic microphone." Its action will be clear from the diagrams, figs. 39 and 40. At T is a tube in which there is water or

another liquid flowing in the direction of the arrow. As the bottom of the tube is contracted so as to give a small opening at this point the water will come

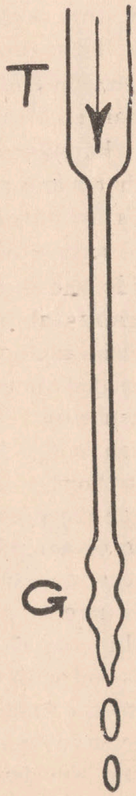

Fig. 39

out of the bottom of the tube in a somewhat fine stream. Such a stream continues in regular smooth

form for some distance below the tube, and then at G it begins to break up and fall in drops. It is found that when we give a shock or other disturbance to the main tube, this favors the breaking up of the water stream to form drops, and the shocks, especially if they are sudden and frequent, act so as to shorten up the distance of the breaking point G from the tube end. The tube is also sensitive to sound vibrations, so that when a sound is produced in the tube there is an action on the water stream which depends on the nature of the sound. Prof. Majorana was thus able to make the water column sensitive to the sounds of the human voice, but it was only after a considerable amount of experimenting that he succeeded in using such a device as a microphone transmitter. This he carries out in the arrangement seen in fig. 40, his design being to make the voice act directly on the water inside the tube so as to change the pressure, and this very near the lower opening of the tube. To do this, he makes the tube of a very strong and solid material, except at one part A, where he provides an opening and places across it a thin and elastic partition. This is connected by a cross rod with a diaphragm of the usual kind belonging to the transmitter mouthpiece M. Speaking into the mouthpiece or making any kind of sound will cause the diaphragm to vibrate, and this movement is transmitted to the liquid within the tube and has an action on the stream of water. In the usual condition of the stream when there is no sound made, there is a straight and un-

broken water column from E to F, as the drops commence to form below F. However, when we make

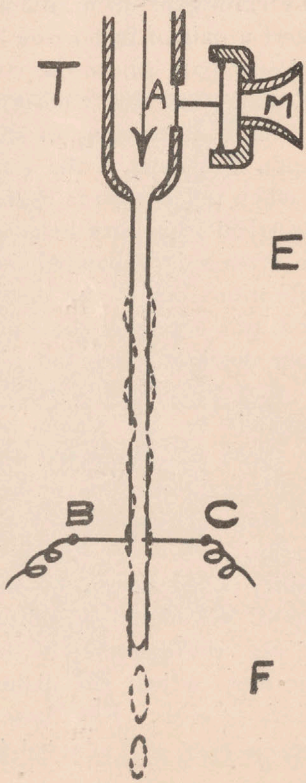

Fig. 40

a sound of a given rate, such as a musical note, in the microphone, the water column is found to con-

tract in a certain way, as seen in the dotted lines, and the contractions increase as we come to the lower part of the column near F. The drops commence to form higher up in this case.

We insert a pair of fine wires B C in the column near the lower part where the contractions are the strongest, and they are connected across by the liquid. A current passing in the wires will thus depend upon the shape of the water column at this point, as when the stream is narrow we will have a higher electrical resistance between the points than when the stream is expanded out from the effect of the vibrations, as in the dotted lines. On the other hand, this action of the water is variable and depends on the kind of sound given in the microphone, so that the electrical resistance between the points depends on the sound in the transmitter. When we speak into the apparatus, we thus have a varying current in the line going from the points, B, C, and this current is made to work the necessary apparatus. We are also able to regulate the conductibility of the stream by changing the nature of the liquid (acidulated or salted water, mercury, etc.), and also the diameter of the stream, and we can furthermore adjust the distances between the metal points as well. For these reasons the new microphone is very well adapted for use in wireless telephony.

Jahnke Transmitter.

An ingenious transmitter has been recently patented by A. A. Jahnke (U. S. Patent No. 948,609).

The object of the present invention is to provide an improved telephone transmitter, especially adapted for wireless telephones, which will be more effective and powerful in its action than those heretofore employed.

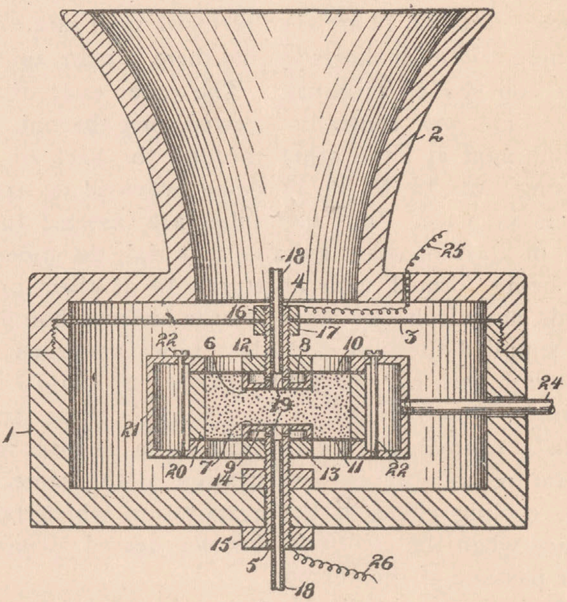

Fig. 41

Referring to fig. 41, 1 indicates a casing of a telephone transmitter, and 2 the mouth piece thereof, screwed to the casing, and between which and the casing is clamped the main diaphragm 3, which is of metal, and of the usual construction.

4, 5 indicate metal tubes, which at their inner ends are secured to thin, oppositely arranged, radio-platinum disks or electrodes 6, 7. Upon or around said tubes, and behind said platinum disks, are metallic cup-shaped terminals 8, 9, and upon said tubes, behind said terminals, are circular sheets 10, 11, of mica. Nuts 12, 13 are then screwed upon said tubes behind said mica sheets to hold them in place against the cup shaped terminals. The outer ends of the tubes are now centrally screwed, one through the diaphragm and the other through the back of the casing, nuts 14, 15, 16, 17, being provided to secure them in place. Into said tubes are inserted tubes 18, of glass or other suitable material, the tubes 4, 5, being formed with apertures 19 at their inner ends, and alcohol or other volatile hydrocarbon fluid is supplied through said glass tubes and runs out through said apertures 19 into the cup-shaped terminals. The function of the alcohol in these terminals is to maintain the electrodes at a uniform temperature and prevent overheating of the same, by the cooling effect of the evaporation which takes place when the electrodes become heated owing to the passage of the current.

20 indicates a cylindrical wall formed of lava or mineral talc, which, with the two sheets of mica, forms a box. The edges of the mica sheets are clamped upon the cylindrical wall 20 by means of a hollow annular clamp 21, the inner side of which is open and receives the edges of the mica sheets and the lava wall, and is clamped thereon by means of

screws 22. Said clamp thus forms a reservoir, into which alcohol can be supplied by means of a supply tube 24. The box is filled with granules which may be, as usual, of carbon. Mr. Jahnke prefers to use carborundum since it withstands heating effect of a large current. The current supply wires 25, 26 are connected as shown to the respective electrodes.

The following is the operation of the transmitter: The annular reservoir and the hollow electrode terminals having been filled with alcohol, the alcohol permeates through the lava and passes into the box containing the carbon or carborundum granules. When sound waves impinge upon the main diaphragm and on that account the two electrodes approach each other, and consequently the resistance of the carbon is diminished, the effect is to heat the electrodes. This results in an increased vaporization of the alcohol, which increases the conductivity of the carbon or carborundum granules, so that the current in the transmitter circuit is correspondingly increased. Obviously the reverse takes place when the electrodes recede from each other.

Mr. Jahnke does not state what kind of carborundum he uses. This is a little obscure inasmuch as the resistance of carborundum is very high.

CHAPTER VII.

Receiving Circuits.

To receive wireless telephone messages only three detectors can be used to get satisfactory results. In their most sensitive succession they are:

The Electrolytic Detector, fig. 42.

The Audion, fig. 43.

The Peroxide of Lead Detector, fig. 44.

While other detectors can and have been used, the three above mentioned are in the end the most serviceable, as they reproduce the voice much clearer than thermo-action or magnetic detectors.

The Electrolytic Detector.

The electrolytic detector may be said to be the most sensitive and the most satisfactory one as it does not break up the voice. Its action is based on the so-called polarization effect.

It seems that as soon as the fine wollaston wire, which is slightly immersed in the electrolyte, (composed of 4 parts of water and 1 part nitric acid) is connected to the positive pole of a battery, the water is decomposed around the wire, it becomes covered at once with air bubbles which form an extremely high resistance.

Incoming waves break through the bubbles, and

establish at once good contact between wire and electrolyte—and the action of the wave is heard in the telephone receiver to which the detector is connected.

This theory is the most satisfactory one, inasmuch as the detector does not work when the fine wire is not connected with the positive (+) pole of the battery.

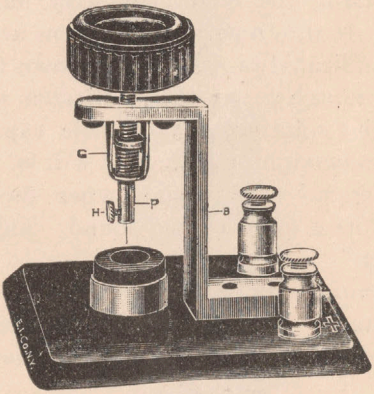

Fig. 42

As it is highly important that not too much or too little current is supplied to the detector, a potentiometer should be used in connection with it, to obtain best results.

The electrolytic detector is operated as follows:

The carbon cup should be filled with the electrolyte composed of 4 parts water and 1 part nitric acid

by using pipette. It has been found that it is not necessary to draw off acid each time the detector is used.

By means of pipette place a drop (not more) of ordinary kerosene oil on top of the acid in the carbon cup. This effectively prevents evaporation, and the acid may be left in detector for weeks. The action is not affected whatsoever.

If a battery is used, its carbon, or positive pole, must invariably be connected with binding post marked +. If all electrical connections are complete as plainly indicated in plan, screw down the thumbscrew far enough to let the Wollaston wire JUST TOUCH the solution. With little experimenting the right immersion into the acid will be found, and the best regulation is reached when the telephone receiver emits a faint hissing sound. This is called the "boiling."

The Potentiometer is then adjusted by cutting in more resistance until the "boiling" almost stops. The detector is then ready to receive the messages.

The Audion.

The Audion, while very sensitive, is as yet in an undeveloped stage, as practically no two instruments work alike and they also lose their sensitiveness in time.

It was found, over twenty-five years ago in Germany, that if a metallic plate and a filament were sealed side by side in an evacuated globe, a current could be passed from the filament to the plate while the filament was lighted, but not otherwise. After a

long series of tests it was discovered that the hot filament emitted a flow of ions which carried the current from filament to plate. This flow is exactly

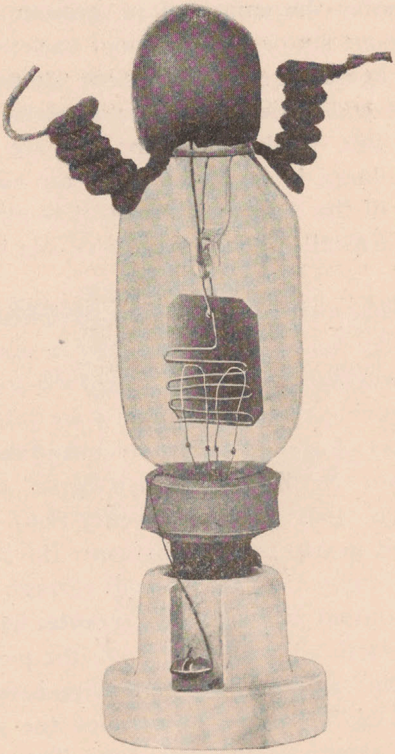

Fig. 43

analogous to that in the gas flame and in the arc, but for a long time it was not considered that it could be used as a nearly ideal wave detector.

After several notable steps of development by different workers, the device now known as the Audion was produced. This has been modified and so changed in the course of its growth that there are now some six or more distinct varieties. In all these the operating principle is the shattering of a column of conducting gas by a received electrical impulse. But, unlike the flame and arc detectors, the gas column is protected from air currents by the globe of the Audion lamp, so it is evident that the great difficulty mentioned above has been eliminated.

The most sensitive type so far designed is called the Grid Audion. This is usually a six-volt low candle-power incandescent lamp with a tantalum filament, having a small platinum plate (about 10x15 millimeters) fastened approximately three millimeters from the filament, and a "grid" bent from rather large (say number twenty-two) platinum wire placed nearly midway between the two. The filament is lighted by three small storage cells, fig. 45, whose output is varied by a rheostat having continuous smooth adjustment. From the positive terminal of this storage battery a wire is led to the adjustable high voltage battery of the telephone circuit, as shown in the diagram. The two leads from the tuning apparatus are respectively connected to the grid and to the negative side of the storage cells.

It has been definitely stated that the Audion is a

potential operated device. But on the same authority it is said that the Audion is dependent for its response upon the total energy received, so the class to which the apparatus really belongs is somewhat hazy.

It is undoubtedly true that the Audion, when in its best condition, is highly sensitive and that it is

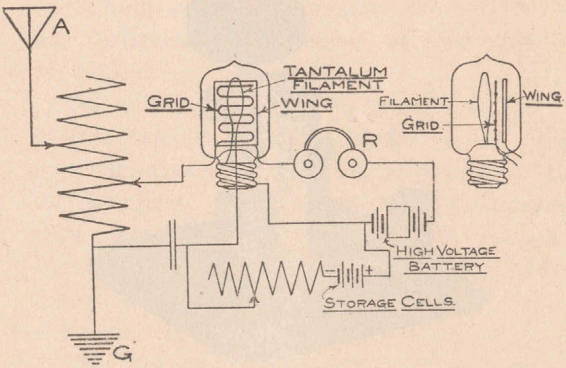

Fig. 45

therefore well suited for wireless telephony. But unfortunately the sensitive condition is extremely difficult to find and still more difficult to maintain. Some Audion-tubes show an extraordinary sensitiveness at first, but quickly grow dull when in use. Other lamps are nearly worthless from the beginning, and none remain sensitive very long.

The Peroxide of Lead Detector.

This detector is sometimes called a dry electrolytic detector.

A peroxide of lead pellet ($PbO2$) is placed between a lead and platinum electrode. (The author improved this by using brass electrodes one of which is platinized, the other is "leadized," i. e., covered with a heavy deposit of lead.)

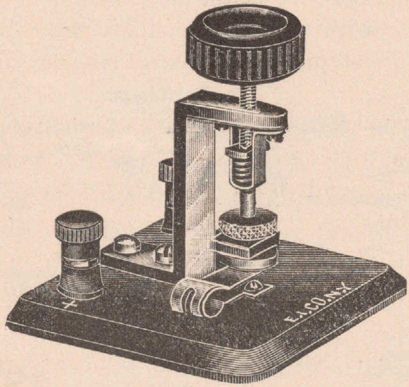

Fig. 44

In fig. 44 the platinum covered electrode is at the top supported by a spring, the tension of which is regulated by the large thumb nut. The lower electrode covered with a deposit of lead is supported by a spring. This gives a greater range of adjustment. According to Prof. Brown—the inventor of this detector—the local battery tends to break up the peroxide of lead into lead and oxygen on the platinum electrode.

On the other side the platinum—peroxide of lead—lead, act as a battery and this tends to cause the lead to be deposited on the anode and oxygen on the cathode. The action of the battery is usually the predominant one, but any oscillatory current enhances the action of the combination, and it is found that lead is deposited on the platinum. This, however, is removed by the current of the local battery as soon as the oscillations cease.

As long as oscillations pass the detector its internal resistance is decreased as has been found by Monckton.

The same authority also states that the resistance of this detector is about 10,000 Ohms. This, however, depends largely on the peroxide of lead pellet, its thickness, etc. In fact, the author constructed such detectors with resistances below 3,000 Ohms by using pellets, which had been compressed with 300 tons pressure by using a good binder, to make the pellet rigid and more conductive.

This detector works best with a pressure of 0.5 volt. A potentiometer is absolutely necessary to get best results.

The pellet must be kept very dry, otherwise a loud roaring "boiling" effect is obtained in the telephones.

This detector is adjusted the same as the electrolytic and the potentiometer must be adjusted till the boiling almost ceases.

The connections are the same as for the electrolytic detector.

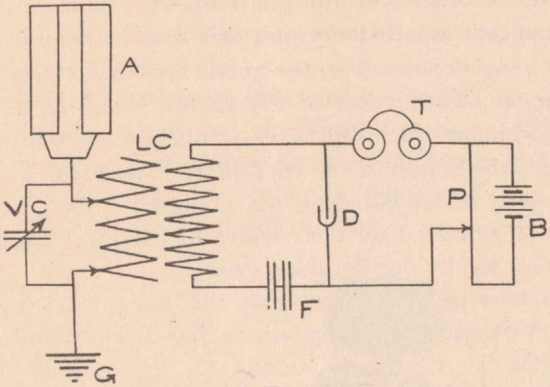

Fig. 46

While hundreds of different arrangements can undoubtedly be used for wireless telephone receiving diagrams, the author would, in addition to above

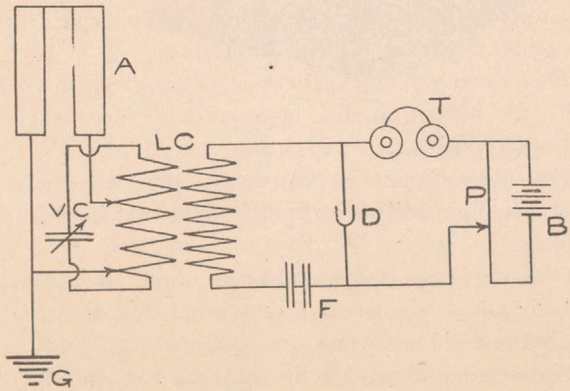

Fig. 47

mentioned detectors, recommend the use of a double slide loose coupler, variable condensers, and looped antennae as shown in diagrams 46, 47, 48.

The detectors shown may be either the electrolytic or the peroxide of lead types.

These diagrams have been found to work ex-

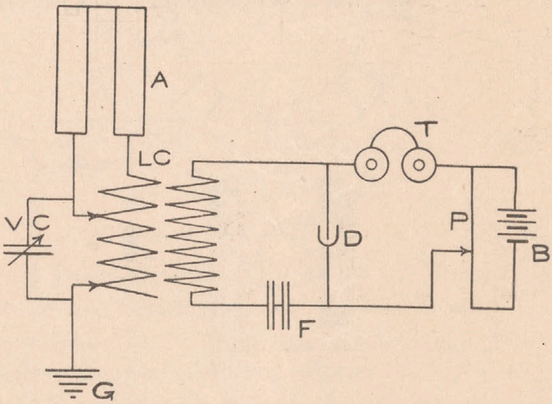

Fig. 48

tremely well in practice as careful and thorough tuning may be obtained.

Fessenden Simultaneous Sending and Receiving System.

In U. S. Patent 923,962, Fessenden describes an ingenious system whereby it is not necessary any more to switch from sending to receiving and vice versa while carrying on a conversation by wireless telephony.

Figure 49 shows a diagrammatic representation of the apparatus and circuits. Figs. 50 and 51 show commutators and fig. 52 a revolving brush employed.

Heretofore in wireless telephony it has been necessary to throw over a switch from sending to receiving as in the early Bell telephone system. In the invention hereinafter described, this is unnecessary. Mr. Fessenden accomplishes this by con-

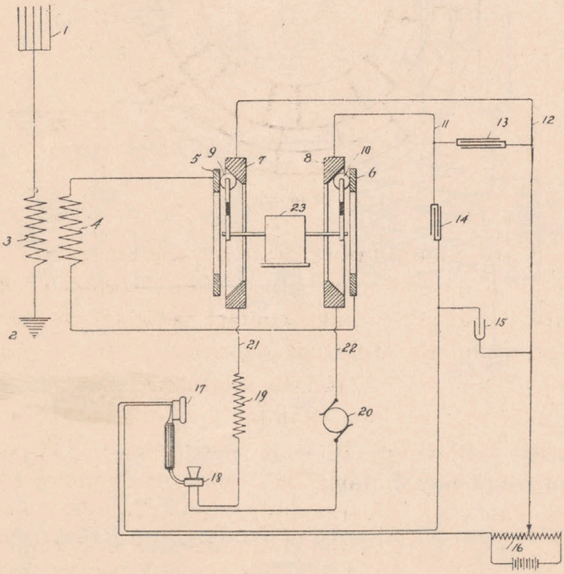

Fig. 49

necting the sending and receiving apparatus to the antenna during a portion only of the total time, the receiving apparatus being connected when the sending apparatus is disconnected and vice versa.

In fig. 49, 1 is an antenna grounded at 2, 3 and 4 are the primary and secondary of a transformer, 7

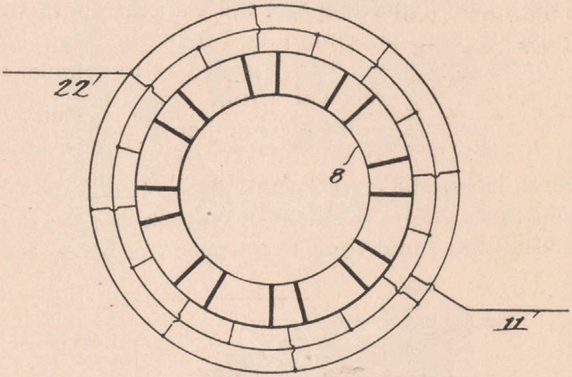

Fig. 50

and 8 are commutators, 5 and 6 are fixed rings, 9 and 10 are revolving balls driven around by the motor 23 so as to make contact between the rings 5 and 6 and the different segments of the commutators 7 and 8. 13 and 14 are condensers, 15 is a wireless receiver, for example a liquid barretter or magnetic detector, 16 is a potentiometer, 20 is a high frequency dynamo or condenser dynamo, 19 is a resistance, 18 is a transmitter and 17 a receiver.

Fig. 50 illustrates the commutator 8 in detail, the broad segments 8 being connected to the lead 11 and the narrow segments to the lead 22.

Fig. 52 shows the revolving brush, 32 being the axle of the motor 23, 30 an insulating joint, 28 a metallic pin and 29 the revolving ball shown at 10 in fig. 49.

In practice the motor 23 driving the balls 9 and 10 causes the receiver 17 to be connected for approximately 4-5 of the time and the transmitter 18 to be connected for the remaining 1-5 of the time. The motor 23 revolves at such a speed as to connect and disconnect the receiver from operative relation to the antenna any desired number of times per second preferably about 10,000 times per second, though it may be considerably less. It is found that when this is done the receiver speech can be understood at the same time that speech is being trans-

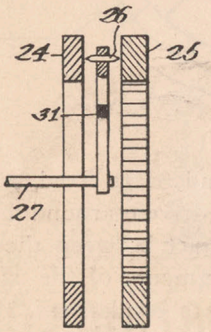

Fig. 51

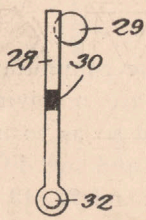

Fig. 52

mitted, without the necessity of switching over from sending to receiving.

Fig. 51 shows an alternative form of commutator in which 27 is the revolving axle, 31 an insulating joint, 25 a commutator, 24 a fixed metal ring, and 26 a pointed wire, making connection between 24 and 25 by a discharge through the air or if desired through gas in an inclosing vessel in partial vacuum.

(THE END)

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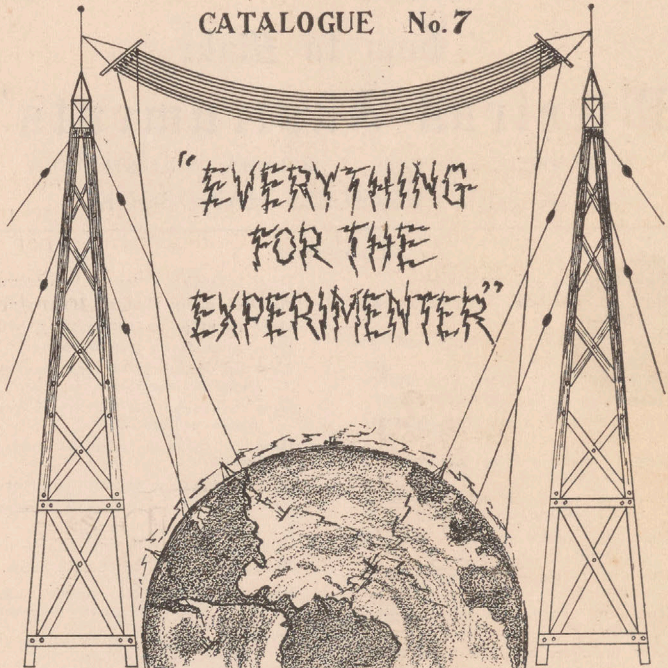

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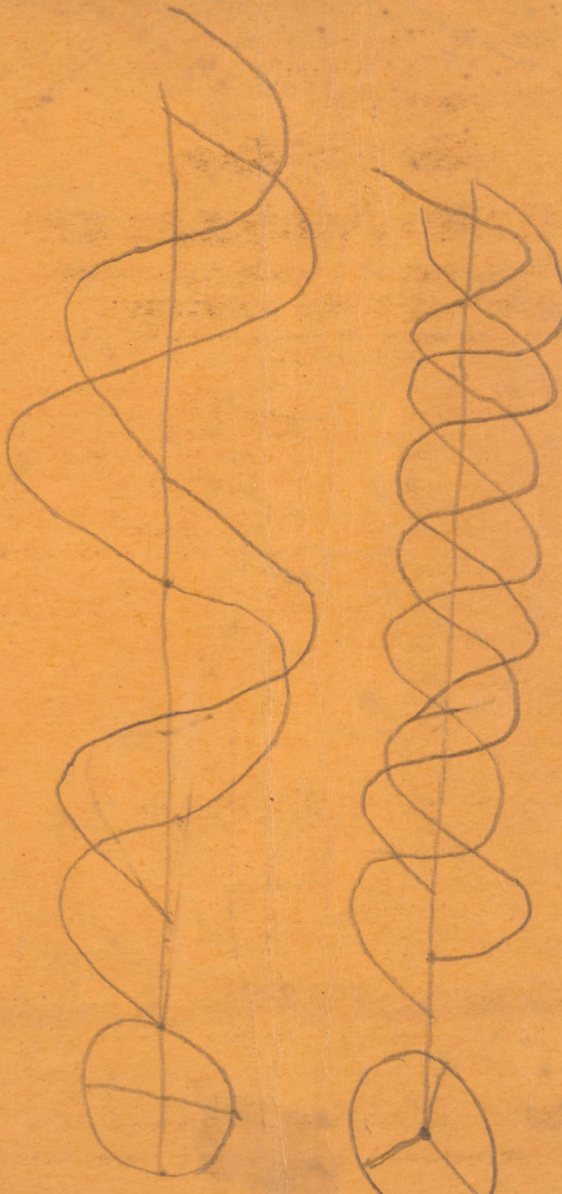

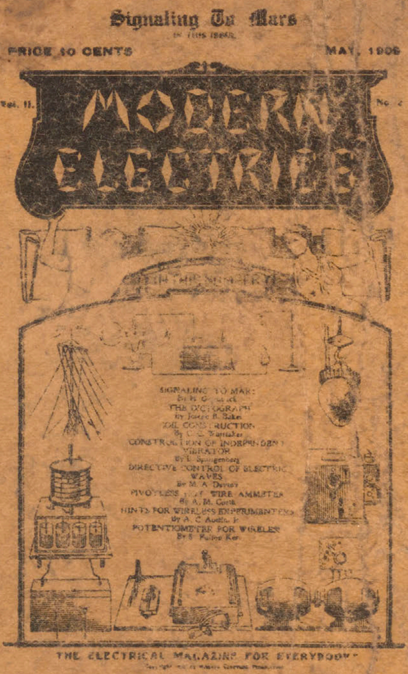

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